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MEASURING THE PAYOFF OF INFORMATION TECHNOLOGY INVESTMENTS: RESEARCH ISSUES AND GUIDELINES

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Abstract

The measurement of IT investment continues to be of interest to academia as well as the business community. However, academic and trade literature cite mixed results from IT investments. Several research and contextual issues might explain the equivocal results and suggest guidelines for future studies. This tutorial discusses these issues and provides directions for future research in measuring IT payoff.

Keywords: Business value, IT payoff, information technology investments

Introduction

As IT investment increases and other areas compete for investments, measuring payoff from IT investment is no longer just an exercise. It is demanded by stakeholders and expected by senior managers. Organizations assume that each IT investment will yield a payoff and the IT department is expected to demonstrate such payoff. Yet, past studies have shown equivocal results of the business value of IT as is summed up in these two comments:

> ***We see computers everywhere except in the productivity statistics.***
> *Robert Solow, Nobel Laureate in Economics* (Atkinson and Court, 1998)

> ***...Information Technologies have begun to alter the manner in which we do business and create value, often in ways not foreseeable even five years ago.***
> *Alan Greenspan, Chairman, Federal Reserve Board, May 6, 1999 (Greenspan, 1999)*

This tutorial explores the research issues and presents guidelines for establishing a mechanism to measure IT payoff.

What are Some of the Issues in IT Payoff?

Firm-level studies generally demonstrate a payoff while industry and economy studies show mixed results. It appears that as we move away from the IT-supported processes, the 'noise' in the measurement increases. Does the source of data change the payoff from IT investment? This tutorial discusses the pros and cons of secondary and primary data sources.

Past studies measured IT payoff from 'variance' as well as 'process-oriented' approaches. Most studies take a positivist approach to look for variance in one or more dependent variables to assess if the investment paid off. There is evidence that when the variables for measuring IT payoff are still evolving, the process approach to measure the IT assets, followed by their impacts, may be a reasonable way to assess if the organization benefited from the investment (Soh and Markus, 1995).

How has Investment in IT been Measured Thus Far?

IT payoff metrics are generally grouped into three broad categories: (1) Profitability, (2) Productivity, and (3) Consumer Value (Hitt and Brynjolfsson, 1996). There are other forms of IT payoff such as risk mitigation (which includes public relations websites, testing for adverse impacts (such as Y2K), and product disclosure information). Therefore, IT payoff measurement should not rely solely upon the financial impact on the bottom line of the company.

The 'Productivity Paradox'

Is the productivity paradox still an issue in IT payoff studies? Recent studies dispelled the notion that such a paradox exists (Brynjolfsson and Hitt, 2000; Jorgenson, 2001; Jorgenson and Stiroh, 2000; Kraemer and Dedrick, 2001; Oliner and Sichel, 2000). The productivity paradox was attributed to past anecdotal evidence-based cross-sectional studies that failed to capture the lag-effects (Kohli and Devaraj, 2002; Mahmood and Mann, 2000).

Another issue is – how should the effects of IT investments be isolated from other sources of investment. This requires rigorous analytical techniques that some past studies failed to apply. The deployment of IT without an effective strategy is also considered a source of mixed results. IT is a tool and when used in the context of a sound business strategy can yield significant payoff. Contrary to general belief, the technology does not have to be very sophisticated for a payoff. Peter G.W. Keen, a prominent thinker in IT management, points out that when all companies can access the same information technology resource, the difference in competitive and economic benefits that firms gain from information technology rests on a management difference and not on a technology difference. Consider the examples of gas stations in the mid-1980's offering customers the ability to pay by a charge card at the pump or some pizza restaurants linking their telephone caller identification facility to a personal computer-based database to retrieve the customers' purchase history and delivery directions as a call came in.

Measuring IT Payoff in E-business Environments

Is measurement of IT investment different in E-business environments? Views differ on whether or not e-business brings special measurement needs. Some argue that e-businesses are no different than other forms of IT, only a different type of asset. Others indicate that the metrics of e-businesses are evolving as is the nature of its business enablement. For example, e-commerce, e-government, and continuous planning, forecasting and replenishment (CPFR) create enhanced collaboration among partners that can expand the payoff from IT investment. Therefore, it is argued, E-business environments should be given special consideration in measuring investment (Barua and Mukhopadhyay, 2000; Straub, et al., 2002).

Research Considerations in Firm-level IT Payoff Measurement

The Dependent Variable

The quest for the dependent variable continues as studies measure different aspects of IT investment in a host of contexts.

Future research should develop frameworks to identify the class of dependent variable (productivity, profitability or consumer value), for the type of investment (operational or strategic), and the appropriate set of variables that would manifest the intended and expected IT payoff at the stage of investment (IT asset creation, IT impacts). In Table 1, we present a sample table of metrics incorporating part of this framework.

Risks in IT Investments

IT investments have different risk profiles. By understanding the risk profile, a company can manage the risks more effectively and, subsequently, improve the potential payoff from the investment. The different components of risk in information systems are defined in Table 2 (Sherer, 2002; Clemons and Row, 1993). Each of these risk components is managed differently. For example, high technical or project risk can often be managed effectively via outsourcing. However, outsourcing or the use of consultants sometimes increases organizational/political risk. Individuals within the organization may resent consultants. Consultants cannot implement organizational incentives for change, and, as a result, employees may not use the system effectively, resulting in lower payoff from the investment.

Table 1. A Matrix of Sample Operational, Managerial and Strategic Variables for Measuring IT Payoff (Source Devaraj and Kohli, 2002)

	Operational IT	Managerial IT	Strategic IT
Investment	Financial Investment in • FTE's (employees) • Equipment • Consulting	Financial Investment and budgeting for • Applications, • Training • Education	Financial Investment and budgeting for • Collaborative technologies • Electronic Data Interchange • ERP
IT Assets	Number of: • Work stations • Automated check-in counters (airlines) • Assembly machines (manufacturing) • Toll processing stations (Toll Road) • Modems (Insurance adjusters in the field) • Information kiosks (Theme parks) • Trainers	Number of: • Process Redesign projects • Extent of Process redesign measured by number of • Person hours invested • Departments involved • Change management initiatives • Managerial Reporting infrastructure such as cost accounting applications	Number of: • Hubs and Routers • Imaging technology • Knowledge based applications • Teams working on strategic systems • Industry and Vendor Partnerships • Decision makers • IT Payoff measurement process
IT Impacts	Number of: • Customers serviced • Hits on the web site • High quality pieces produced • Problems resolved • Returning customers • Customers referred by other customers • Orders processed/day • Sales/Employee • Loan approval days • Rain checks issue • Special orders placed	Number of: • Escalations • Missed deadlines • Extension of Project end dates • Reporting errors • Technology substitution • Mid-project process redesigns • Adverse Event Episode detection (Healthcare) • Product Recalls • Average Length of Stay	• Actual usage by period by user • Extent of integration of IT into corporate decision making such as the number of • Reports requested • Scenarios analyzed
Organizational Impacts	Profitability • ROI • ROA	• Employee Turnover • Maintenance Expense • Downtime • Mortality Rate (healthcare)	• Market share • Ranking • Industry Awards • Customer Service Rating • Stock price • Financial Rating

Every IT investment has a unique profile. Implementation of a packaged ERP application may be a low technical risk but high organizational risk. The level of organizational risk varies with the organization, its culture, and degree of change to existing business processes. A supply chain management system may have very high collaborative risk or it may have high organizational risk, depending upon the level of change required in internal as well as external business processes. Understanding the risk profile helps organizations plan effective risk management strategies that can increase potential payoff from IT investments.

Table 2. Information Systems Risks

Risk	Definition
Technical	The technology doesn't work, either because the appropriate technology to provide the necessary functionality is unavailable, or the wrong technology is used, or the software/hardware fails.
Project	The project cannot be completed on schedule or within budget, with adequate performance or in accordance with some measure of project success.
Organizational/ Political	The system is not used effectively because of organizational structure and internal politics.
Financial	The system does not achieve expected benefits
Systemic	A system is so successful that competitive response reduces the value of the system or unfavorable regulatory changes are made in response to the project's success
Disaster	The system is harmed by external disasters such as flood, fire, or other natural disasters and terrorism or war
Compatibility	Two or more systems cannot share data effectively because of incompatible technologies.
Security	Unauthorized access to systems can result in alteration or theft of information.
Collaborative	The information needed to collaborate is not shared effectively between business partners.
Competitive	Unique ideas, operating procedures, and/or customer information, is acquired by competitors and used to their advantage

Using Activity Analysis to Realize Business Value

IT investments can drive changes in business processes. These changes often impact activities across the entire value chain. The responsibility for ensuring that these changes do, in fact, occur can be distributed across different functional activities. Business managers, not IT managers, are responsible to make sure that the changes to business processes that should accompany the implementation of a new information system do, in fact, occur. By identifying those changes, an organization can assign responsibility to appropriate individuals and groups to ensure that these benefits accrue. Activity based management methods provide activity based information that can be used to assess the impact of a new information system on various activities across the value chain (Sherer, et al., 2002a). Information at the activity level enables responsibility assignment to insure the full potential payoff from an information systems investment.

Change Management

Part of the information systems investment process involves adoption of new solutions, which requires organizational change. Thus, the use of change management techniques such as change agents or facilitators and effective change communication strategies can help assure the full potential payoff from an information systems investment (Sherer, et al., 2002b). These tools can help manage user expectations, promote user involvement, and overcome resistance to change. Effective change managers assess the preferences and expectations of stakeholders, and use communication tools and facilitators to meet or alter these expectations. This will help organizations achieve full value from their information systems investments.

Technology Justification Models

The purpose of the justification models is to convert the relationship between IT investment and anticipated payoff into a logical or mathematical form, while accounting for other factors that might affect the measurement along the way. The primary objective of a model is to isolate the surplus profits that can be attributed to the investment. The complexity of these models increases as other factors are added on to either the cost or benefit side of the equation. In addition, certain justification models may be more appropriate given various organizational imperatives such as upgrading existing technology, investing in IT infrastructure, or acquiring new IT applications. Technology justification models can vary from intuition- based cost-benefit analysis, breakeven point, Net Present Value (NPV), Economic Value Added (EVA), to statistical models.

When the number of complaints decline substantially following implementation of a Help Desk, a rigorous analysis may not be necessary. However, cost-benefit analysis require gathering substantial data that account for varying types of costs as well as benefits, many of which have been described above. Essentially cost-benefit analysis is explicitly spelling out the costs and benefits in a formula such as Equation (1) in an investment that improved productivity of an operation.

$$P = \{(\Sigma (H_b - H_a) * W)\} - \{C_h + C_s + C_l\} \quad (1)$$

(Benefits) (Costs)

where

P = Payoff
$\mathbf{H_b}$ = hours before implementation
$\mathbf{H_a}$ = hours after implementation
W = average wage rate
$\mathbf{C_h}$ = hardware costs
$\mathbf{C_s}$ = software costs
$\mathbf{C_l}$ = labor costs

Information economics is a variation of cost-benefit analysis that accounts for intangibles and uncertainties in information systems projects. In addition to determining costs and benefits, it ranks and scores intangibles and risk factors associated with the investment (Wen and Sylla, 1999).

The time value of investment is represented in Net Present Value (NPV). How do we put a value on the time value on the money? Calculating the Discount Factor (DF) is usually the more challenging part of the calculation because it involves a forecast of future returns. In some companies, the discount factor is set by administrative fiat.

While NPV provides information about the time value of the investment, it does not take into account the risks or opportunities created by stopping, decreasing, or increasing investment in the future. Investment in real world scenarios is more complicated than a yes or no decision to invest. Given the additional information about how IT investments yields payoff, management has the option to increase or decrease investment any time after the first phase of investment. This Real Options approach helps managers understand the potential payoff from IT investments in a multi-phase investment scenario (Benaroch and Kauffman, 1999; Benaroch and Kauffman, 2000). Often, it is worth the risk to continue investing in IT initiatives, even if the investment is minimal, because of the potential of a portion of the payoff in the future. Traditionally, these situations challenged investors in Research and Development or high-risk ventures such as oil drilling. In the IT context, failure to make an investment in the network infrastructure, such as laying cable, can severely restrict a company's competitive capability to add computer applications and provide new services. Even when it is possible to retrofit infrastructure to adopt new applications, the valuable time lost in upgrading can put the company at a disadvantage.

Statistical approaches, something that IS faculty are most familiar with, apply statistical analysis to understand the relationship between the investment and payoff. Most commonly, the first step is to examine the correlation table listing the strength of relationship between the investment (independent) variables, and the payoff (dependent) variable. In the next level of payoff analysis, the extent of the contribution of each item is related to performance by constructing a regression equation (Devaraj and Kohli, 2000).

IT Payoff in Developed vs. Developing Economies

A potential area of future research in IT payoff is to examine the differences between IT payoff in developed and developing economies. The limited technology and the constricted financial resources limited the deployment of IT in developing nations. However, for the same reason they became creative in IT investment. For example, many developing nations with no land-based telecommunications infrastructure spent heavily in wireless systems, whereas developed economies (such as the US) with significant investments in land lines were relatively slow in using wireless. Similarly, several developing nations completely by-passed the mainframe era of computing because they computerized their operations when the client-server technologies were available.

Given such differences, is IT payoff in developing economies measured differently because the investment was made following the 'lessons learned' from those that invested in the past. Do limited financial resources lead to creative ways of deploying and measuring IT investment?

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